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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR, C. A. CHANT ASSISTANT EDITOR, F. S. HOGG

David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS:

C. S. BEALS
Acting Dominion Astronomer
Ottawa

J. A. PEARCE
Dominion Astro-physicist
Victoria, B.C.

A. THOMSON
Controller of the Meteorological Service of Canada, Toronto

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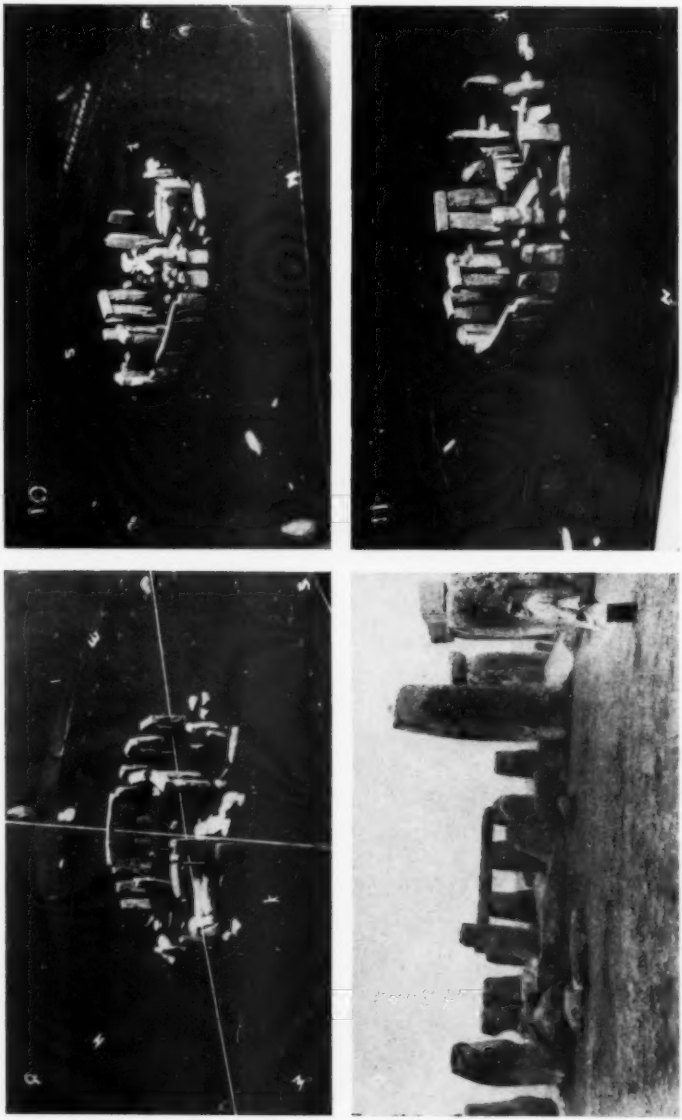

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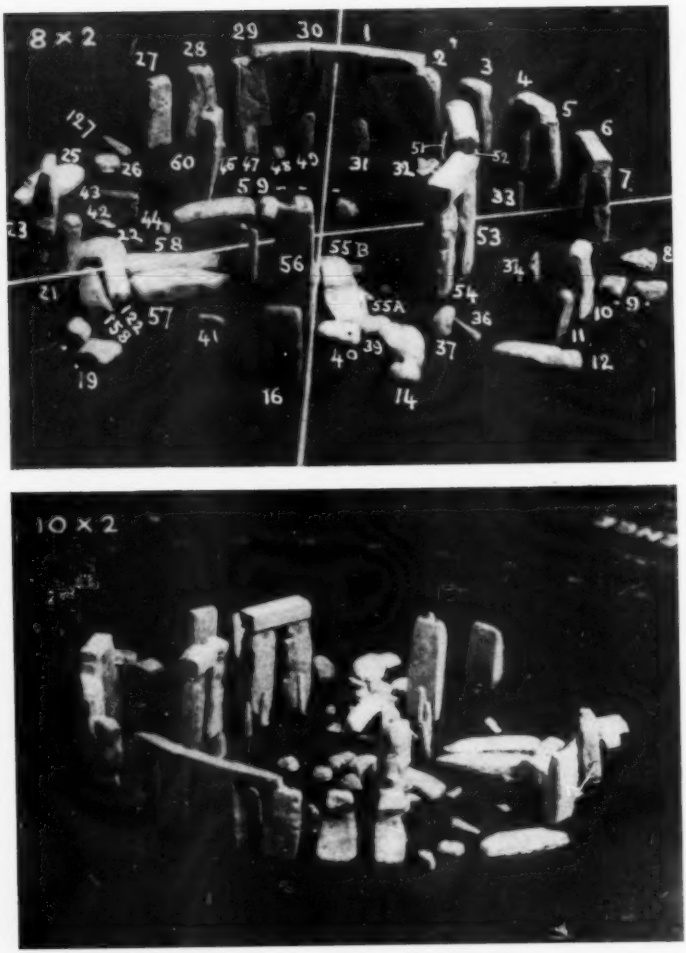

Figures 8x2, 10x2

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STONE CIRCLES AND STONEHENGE

By W. H. WHITE

(With Plates I and II)

CAMPING, one September long ago, on smiling Bodmin Moor, westward lay Dozmary Pool, traditionally the lake into which covetous Sir Bedivere, overawed at last by the eloquence of the dying Arthur, flung Excalibur, and returned to relate how an arm emergent "clad in white samite, mystic, wonderful" caught the sword, brandished it thrice, and sank forever.

With all apologies to Cornwall, the lonely Pool looked rather like a prairie 'slue'. But British waters of mystery must needs be bottomless; so, naturally, sans samity or dimity, I waded in. And in, and out, unswum: it had indeed the third dimension, or lack thereof, characteristic of those oases.

Disillusioned, I trudged east towards "Hut Circles" promised by the map. But the custom is, to take in a patch of moor, "put three lives on it," sow three grains mixed, and snatch a crop of sorts from the harvest weather. Small ruins get lost, but a prize was a Circle, several yards across, of eight or nine flat stones, waist-high or more, (as many missing) rather suspiciously upright and well set. "Yes," said the farmer, "I'd tired of seeing them lying there spoiling turf, so I and my man we took a day off from work"—I liked that—"and set 'em up again: they shelter a lamb or two, come spring." Two men might well heave one on end, but they were too weighty to lug about: it was genuine enough resto-

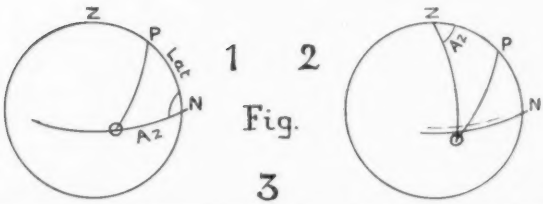
ration, and had fully as much right to be, as the stone Circles the Welsh set up nowadays for their bardic Eisteddfods.

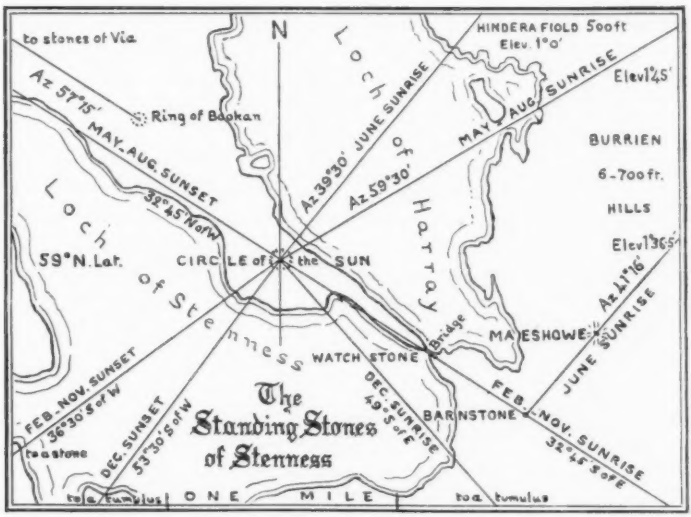
Climbing back 'into England,' on unsmiling Dartmoor I traced another Circle, close flanked by many little hut rings, or one might say, hut 'snails,' for each had had a short porch curling out, which must have been a great domestic improvement. A doleful writer concludes that stone circles were mainly sepulchral: would he say as much of St. Nicholas Church, Great Yarmouth, with 4,000 memorials in its aisles—and 40,000 living parishioners? Here, plainly, was the public meeting place of a once sizable community, a place the youngsters would sometimes claim for games. Then would be heard an elder—"I walk across in as many steps as I have fingers and toes, and back in twice: now why, when they make me walk round, can't I do it in thrice, but have to set three steps more?"—puzzle pondered long, perennial π.

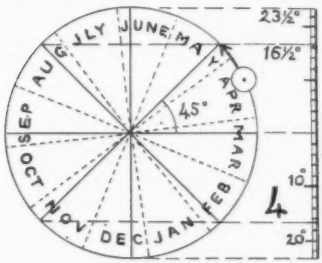
"Wiseman, standing in mid-ring, we went out to till the land when you told us the dark days were past, and the sun rising beyond Wat the flesher's hut: when is our digging and planting to be ended, when will the bright days of growth be due?" "When the glowing sun shall rise along the lane by herdsman Ned's. And then go all of you to that long stone lying out under the seven stars, and drag it hither, and plant it firm and upright, a maen-hir, where I shall show you, and when the sun sets beside it, then get you to harvest."

Exact measurement doubtless started with point stars crossing straight-line horizon. First astronomical instrument would be the two fixed stumps which caught each other's shadows both at sunrise and sunset, once as days lengthened, once as they drew in. This latter was the time to prepare for sowing on the falling of the Nile: those days defined, and halved, a year. They marked east and west: to them conform the Pyramids, churches, graves. But nowhere did the former mark a season of agricultural importance: the moon took it, by a curious double hitch, and drags Easter up and down the calendar.

Stars were fixed and faithful, and temples were built towards their rising: yet precession was at work, and in a dozen generations ancestral accuracy would become discredited, and building alterations be necessary. It hit the conspicuous Pleiades hard: the Parthenon, built 455 B.C., seems oriented on their rising 14° N.


Z
P
Lat
N
Az
1
2
Fig. 3
Z
Az
P
N


to stones of Via
N
Loch of Harray
HINDERA FIELD 500ft
Elev. 1°0'
Az 57°15'
Ring of Brodgar
MAY-AUG. SUNSET
Az 39°30' JUNE SUNRISE
MAY-AUG. SUNRISE
Elev 1°45'
BURRIEN
6-700 ft.
HILLS
Elev 1365'
Az 59°30'
38°45' N of W
Loch of Stenness
59° N. Lat.
CIRCLE of the SUN
Az 41°16'
Bridge
MAESHOWE
JUNE SUNRISE
WATCH STONE
FEB.-NOV. SUNSET
36°30' S of W
DEC. SUNSET
53°30' S of W
DEC. SUNRISE
49°5' S of E
BARNSTONE
FEB.-NOV. SUNRISE
32°45' S of E
The Standing Stones of Stenness
to a stone
to a tumulus
ONE MILE
to a tumulus


23½°
16½°
10°
20°
JUNE
JULY
AUG
SEP
OCT
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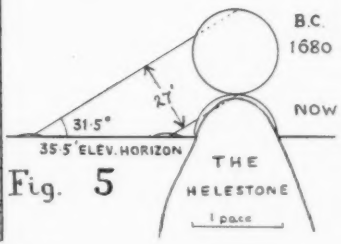
DEC
JAN
FEB
MAR
APR
MAY
45°
4


B.C. 1680
NOW
27'
31·5°
35·5° ELEV. HORIZON
THE HELESTONE
1 pace
Fig. 5

Figures 1—5

of E. at that date; the two-mile straight 'avenue' a half-mile N. of Stonehenge, the Cursus, was sighted for them 8° N. of E. when their declination was only 4.5° N., and that was 1500 years earlier —before they'd learnt to ring a racecourse and hug the rails.

Slow-drifting stars for astronomers, the fickle planets for the faint of heart. "Doubtless Mother Astronomy would starve," wrote Kepler, "but that daughter Astrology earns a rich reward." But we want timekeeper Sun: nigh three centuries Mother Greenwich has lived on the grant of a watchman's wage; young step-son TIM, London's telephone talking-clock, now nets five-fold as much. Precession does not upset the Sun, he rules it, his temples endure, sighting his rise or set at a change of season, or sometimes his farthest north.

Measurements needed for this paper show plainly that the 'foot' was not in use, so, as a natural unit we all know, I made the longest distance in Stonehenge, 256 feet = 100 paces (= 100 p.) —and away went queer primes and odd quarters. 2.56 feet = 30.72 inches is easy for modern man; that, and the double-arm span, 2 yards. Be sure the master-builder of old was no little man: he used his arms across what stood, and his legs along what lay, and he never stooped.

Let us step and look at a great Circle of the Sun, for which I rely largely on my valiant professor of yore, Sir Joseph Norman Lockyer, and on Mr. James Tait, now of this City, who claims it as finest of all; Stenness, 59° N., in Orkney, land of his birth. In Fig. 3, from the centre of a 140-pace diameter circle, round which stand 15 (left of more than double) rough slabs, 3 to 6 p. high, of the local fissile Devonian flagstone, Hindera Fiold, a 'natural tumulus,' 500 feet high and 5½ miles away (a horizon elevated 1° rather exactly) bears 39° 30′ E. of N. But from the tall Barnstone, the summit of a large tumulus, Maeshowe, bears 41° 16′ E. of N., towards a ridge measured as 1° 36.5′ high. Both sight-lines were to catch the sun rising at its farthest north: whence the inequality?

In Fig. 1, where P is the pole, N the north point, NO the horizon and O the solstitial rising sun's centre, PNO is a right angle, and cos (azimuth ON) = cos (Polar distance PO, now 90° − 23° 27′) / cos (lat. PN). From latitude 40° to 60° this gives the long curve of Fig. 6, its geometrical solar solstitial backbone, serving summer and winter solstices, rise and set—but only a backbone. For no-

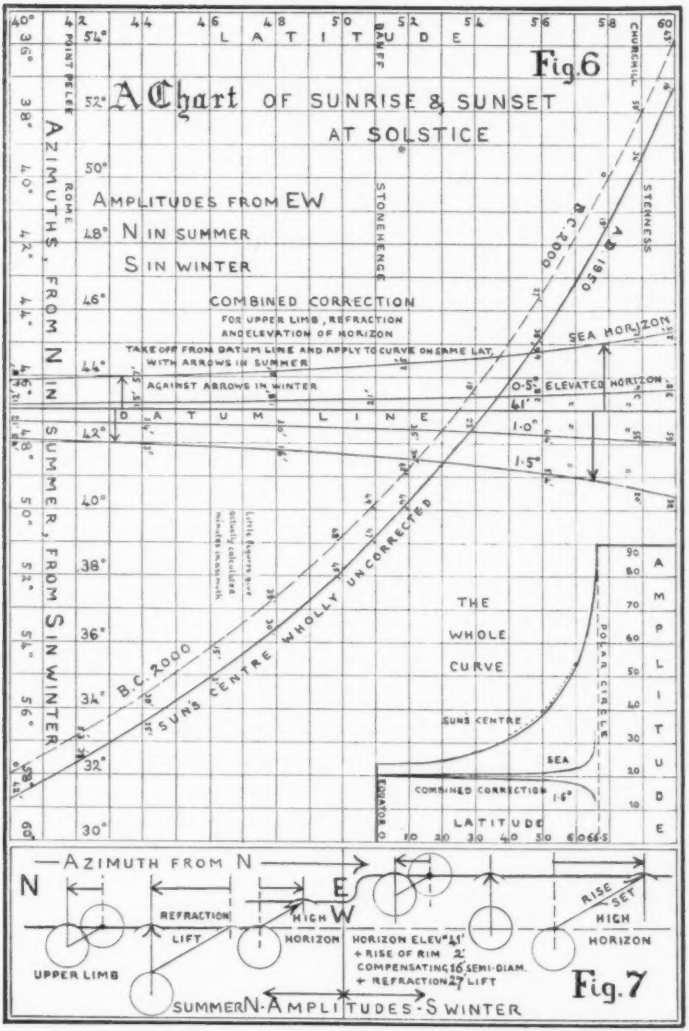


Fig.6
A Chart OF SUNRISE & SUNSET AT SOLSTICE
AMPLITUDES FROM EW
N IN SUMMER
S IN WINTER
COMBINED CORRECTION
FOR UPPER LIMB, REFRACTION AND ELEVATION OF HORIZON
TAKE OFF FROM DATUM LINE AND APPLY TO CURVE ON SAME LAT. WITH ARROWS IN SUMMER
AGAINST ARROWS IN WINTER
SEA HORIZON
0·5° ELEVATED HORIZON
1·0°
1·5°
DATUM LINE
LATITUDE
AZIMUTHS FROM N IN SUMMER, FROM S IN WINTER
BC 2000
AD 1850
SUN'S CENTRE WHOLLY UNCORRECTED
THE WHOLE CURVE
SUNS CENTRE
SEA
COMBINED CORRECTION 1°6'
EQUATOR
POLAR CIRCLE
AMPLITUDE
PAINT PEELER
ROME
STONEHENGE
CHURCHILL
STENNESS
BANFF
AZIMUTH FROM N
N
E
W
REFRACTION LIFT
HIGH HORIZON
HORIZON ELEV. 41'
+ RISE OF RIM 2'
COMPENSATING 16' SEMI-DIAM.
+ REFRACTION 27' LIFT
RISE
SET
UPPER LIMB
SUMMER N · AMPLITUDES · S WINTER
Fig.7

Figures 6, 7

body waits for the sun's centre; we take his rising rim, 2′ of it, 1/16 his diameter, about a quarter-minute's wait to make sure that first flicker meant business, and his geometrical centre is still 14′ underground. And more, for atmospheric refraction is heaving it up from beneath. On the other hand, we have asked the sun to climb, over two different hills.

It adds up to this: at 'Sunrise' over the Sea, the zenith distance *ZO* of his centre must be reckoned 90° + 14′ + 35′; over a ½° elevated horizon 89° 30′ + 14′ + 29′; over a 1°, 89° 14′ + 24.5′; over a 1½°, 88° 30′ + 14′ + 21′; and over a 2°, 88° 14′ + 18′.

The triangle to be solved is Fig. 2, and, writing

$$(ZO + ZP + OP) = 2s,$$ we have

$$\tan^2 \tfrac{1}{2}(\text{azimuth } PZO) = \sin(s-ZO).\ \sin(s-ZP)/\sin s.\ \sin(s-OP)$$

The results are plotted on the Chart as differences to be taken off by dividers from the Datum Line and applied to the 'backbone' on the same latitude, as there directed. It then covers both summer and winter solstices, rising and setting, for most of Canada and Europe. And residents in the Southern Hemisphere simply interchange N and S throughout.

Since, with us, the sun arrives from the north, Fig. 7 shows how using the upper limb instead of centre displaces all positions northwards. And refraction, lifting it still higher, evidently keeps all farther north. Whereas building a wall around the horizon, to be climbed over, plainly has the opposite effect. Hence the necessity for the corrections, and the curious inequalities they produce.

Plotting now the Stenness conditions, the Circle-Hinderafiold line should bear 40° 19′ E. of N. instead of 39° 30′ (excess 49′), and the Barnstone-Maeshowe line 42° 2′ instead of 41° 16′ (excess 46′), —discrepancies too great altogether.

Some change working through the centuries? Yes, the obliquity of the ecliptic is decreasing, by half a second a year (Stockwell, *Smithsonian Contributions*, 1873), in 2000 B.C. it was 30′ greater than its present 23° 27′. The pecked line is calculated 'backbone' for that date: at latitude 59° it calls for 85′ lesser azimuth, a reduction of 85/3950 = 0.0215′ yearly. The Circle-Hinderafiold line was therefore laid 49/0.0215 = 2270 years ago, with declination 23° 44′, about 300 B.C., and the other line 150 years later.

Be it said at once, the probable error is great: B-M was none too well surveyed, while over Hinderafiold I have relied on the

contour map, and a lower horizon there would wipe out the difference altogether. It is scarcely more than a gamble with Norman Lockyer's venture into antiquity.

But that this typically crude, though astronomically highly complete, structure, on its remote island, works out a millennium after the wealthy Stonehenge he measured, need cause no more surprise than that the churches of the Canadian prairie lack the grandeur of the 700 year-old Minster of New Sarum. Maeshowe, 'the maids' house,' 35 p. diam. by 14 p. high, contains a hall $6 \times 6 \times 5$ paces, with smooth walls of huge flagstones, the skilful fitting of which archaeologists look upon as late Pictish. On them are scratched runes recording its breaking into, A.D. 1152, by Norsemen, who found no treasure, but held a Yule carouse.

Passing over winter solstice lines as seldom of use, the Main Axis, lying in the trough of the island, is aligned by Circle, 7p. watchstone, Barnstone, and between them, until 1814, the Stone of Odin, through a hole in which, head-high, watch could be kept either way. The farmer who then broke that up, to build a cow-house, left the island instead, for the populace had endowed it with magic powers. Photographs show a slight rise of land from its site either way, and as the line of sight runs straight through, on 32°45′ S. of E. or N. of W., our chart holds us to the datum line (= 0.7° rises), *ZO* is 90, and Fig. 1 serves to ascertain what was the declination of the Sun when he rose or set in those directions. *PN* = 59°, *NO* 57°15′, *PO* comes 90° ± 16°11′ declination N. or S.

Further, a sideline from the Circle, 30°30′ N. of E. rising 1°45′ over 700-foot Burrien Hill, gives 16°10′ N. This last calls for Fig. 2 and the equation

$$\cos OP = \sin OZ. \sin ZP. \cos OZP + \cos OZ. \cos ZP,$$

Modernizing this from the age we have found, by reducing it

$$(23° 44′ - 23° 27′)/23° 44′ = 0.012 \text{ of itself, to } 15° 59′,$$

this is by average ephemeris the sun's declination in Britain—

Feb. 5, 15h(observed sunrise Feb. 6); May 4, 21h(obs. set); Aug. 9, 10h(obs. set); Nov. 6, 13h(obs. rise 7th).

These divide the year into

$23 + 31 + 30 + 4 = 88$ days Spring, $27 + 30 + 31 + 8 = 96$ days Summer,
$23 + 30 + 31 + 6 = 90$ days Autumn, $24 + 31 + 31 + 5 = 91$ days Winter.

[I see I have switched from azimuth to amplitudes N. or S. of EW.: they seem more natural in watching the sun's annual swing. Figs. 1 and 2 work azimuth from N. Fight shy of azimuth from S.]

In a temperate climate, these were days of changing season. Feb. 6, winter sloth must be ending, digging, draining, sowing, planting set about. All seed or seedlings must be early in May, the bright season of new life all wanting tending. Harvest must be on the way in August, in November it is time to garner all under shelter. For each, give a man—and the weather—as many days' grace as he has fingers, the limit of needful counting skill.

The day is the unit, and there is no urgency to one or two; the sun is slipping along the horizon his own width daily: 16° or 16.5°, the half-quarter of his annual cycle, Fig. 4, mattered little. Circles and longstones could be small and crude—as in after years were the scratch sundials on the church wall—200 stone circles of all sizes and states of disrepair survive in Britain, and nobody can tell how many wooden ones there were: village communities would have their own calendars—their own temples—and they'd hate not to differ a bit.

" 'Course we're all up and hungry, late sunrise Febr'y and November. No, what can a man do, dawn May or August, all soppin' o' dew: wait till sunset, us don't turn in afore sun then. November and Febr'y sunset: lucky if you see sun within an hour on't. [So there is the Stenness main axis, and we shall see it again.] Equinoxes! do I want tellin' when gales blow? Walk a mile to see start of the longest night? Art' fond of wolves? Turn out the very earliest sunrise of the year? no, nor wait up three parts of his whole round after: working man wants his sleep, let they girls go dabble their faces in the dew and welcome! Longest day? lay you don't find which 'tis of five: sun's too steady. No, let Egypt have that, where men can't work middle day for heat, yet sun don't rise so early by hour and a half. Oh ay! the gentry folk down south ha'got the new craze, built a master fine temple they have, and pay a rare larned chap wholly well to tend to't. Les' us go look at'n. . . ."

The ancient speech unknown, I have put that in parlance of to-day, when still 'Norman' landlord demands his rent Quarter Days, equinoxes and solstices with a handful of grace; but English farmer thinks first of the half-quarter days, Feb. 8, May 9, Aug. 11, Nov. 11, and by them runs his farm.

Of Candlemas and Valentine's, Mayday and Whitsun, Scottish Lammas and 'the Twelfth', Hallowe'en (and the English boys' substitute, Guy Fawkes) Mayors' day, Martinmas, etc., others must tell.

Stonehenge

Salisbury Plain is an expanse of prairie strange to English eyes, rolling apparently unbroken to the skyline. Geologically contemporaneous with the prairie, its soil is very different, chalk, the stuff Canada imports for blackboard use—England, her S.E. largely composed of it, naturally imports Canadian gypsum to make plaster 'chalks.' Solid, but soft, it is soluble in rainwater, containing CO_2; the short fine turf grows on a topsoil leached free of lime, the cross valleys, deep sunk and unseen, were dissolved out, their rivers run crystal-clear with the 'hardest' of water.

Minute calcareous shells of unicellular foraminifera sank through deep water to consolidate into the white chalk: more fragile siliceous tests of radiolaria and diatoms rained down too, slowly their silica re-dissolved and seeped through the porous mass to concentrate in nodules, from fist to head size, of clear colloid silica, flint, dark from traces of end-products of organic matter, queer-smelling when struck, harder, when dried out, than glass, high valued for tools and weapons, sought in pits and long-galleried mines dug out with a horn pick, shaft and brow-tine of the red deer.

Depths changed, and upon the chalk were swept sands and coarse gravels; still the silica fell, ultimately flooding the lowest layers, cementing them into stone of very uneven texture, from brown-sugary sandstone to almost adamantine quartzite, the 'Woolwich and Reading beds'. Buried under the 'London Clay' and later uplifted, they cap Greenwich Hill; upon them, in 1675, Wren built the Observatory; 260 years later they saved 100 tons of concrete in the foundations of the new meridian circle. North of the Plain, in shallow chalk valleys, broken masses lie in droves;

sarsens, saracens, English epithet of foreigners in Crusading times: of them STONEHENGE was built: 51°10.7′ N., 1° 49.5′ W.

The flatter blocks being chosen, bulges were pounded with 40 to 60-lb. 'mauls,' rounded lumps of hardest rock, until crumbled deep in furrows; flint chisels and hammers, spheroids of handy size, cut out the ridges: fire and water split stubborn parts. On tree-trunk rollers they were trundled along, 16 miles or more, only an infant chalk-stream or two opposing, often dry. Three miles short of their destination stood a wooden forbear of the structure to be, discovered from the air in 1925, its decayed post holes growing taller wheat; concentric rings of 12, 18, 18 small, 16 and 22 ten-inch holes, ring of 60 small, ditch, and sighting outliers, the first 'Woodhenge'. Labour indeed, but turn aside and view the deep ditches and climb the steep ramparts of the hill fortress of Old Sarum, merely your easiest reached of the countless Rings, Camps and Castles that stud this countryside, work of a vanished race.

Arrived at the chosen site, a very shallow declivity of the Plain—in which Stonehenge nowadays at first distant view, looks disappointingly like a little herd of smoky-hued cattle—they received their final trimming; their upper ends were squared off, leaving two cup-shaped tenons standing, and their faces were worked over into a uniform fine pitting by tapping with a flint pebble. Thirty holes were dug round a circle 40 paces inside diameter, their outer sides vertical, their inner part-slanted, and the sarsens were tipped in just as telegraph poles are set up, and packed with broken-off blocks, old hammers, blunted flint chisels, a chance old antler pick, stone chippings, and chalk rubble, all well rammed in with the mauls. These 30 so planted, their untrimmed lower ends variously deep, stood uniformly five paces high above ground; they average two yards wide by a yard or more thick, and weigh about 20 (long) tons. Forming a continuous ring were lintels one pace thick, mortised out to take the tenons, and toggled together at their ends. These stones 'hanging' aloft, found in no other circle, led to its (Anglo-Saxon) name.

Then came an inner partial ring, averaging half the diameter, of horse-hoof shape, composed of five close (shoulder-wide) pairs, of greater bulk and height, rising over 6, 7 and 8 paces, each pair carrying, with tenon and mortise, a capstone $1\frac{1}{2} \times 1\frac{1}{2} \times 6$

paces: these constitute the Trilithons. Six paces in front of the central and tallest, across the axis and almost flush with the ground, lies the thinner Altar Stone, also $1\frac{1}{2} \times 6$ paces, of micaceous sandstone from some locality undetermined.

Of the small bluestones much mystery has been made. But in Salisbury Cathedral one is struck by the beauty of its columns, of creamy-white Portland stone clustered round with slender polished shafts of dark Purbeck marble, a novelty of 'Early English' 700 years ago. Nor yet so novel: 3000 years earlier the Master-Builder had seen his sarsens, shorn of their 'grey-wether' lichen fleeces by the masons, standing stark, tawny to blotchy-brown —imagine a keyboard with its ivories stained and no blacks. Before each he must set a pillar or two of that fine smooth dark-grey stone, blue by contrast, of which his hand held a sea-worn pebble: whence could it be won, with scant quarrying skill?

Nearly all the bluestones are of 'diabase', into which lava congeals when forced up into cracks in the strata above, forming wall-like 'dykes'. Variations in composition, temperature, and rate of cooling, result in numberless distinctive micro-patterns; and these have been traced to Prescelley, in S.W. Wales, where a dyke crowns a ridge. Contraction cracks enabled this to be split into strips of three or four tons, and these were run downhill to a tidal creek, and sailed, round Land's End, to the southern Avon. Thence a water-frolic for the landsmen to pole them 50 miles up its clear current to a landing, only lately spotted from the air, three miles south of the Circle, which is 342 feet above sea-level. There delivered, and trimmed to shape—half away, judging by the chips unearthed—they were duly set up, most in a ring leaving a $3\frac{1}{2}$-pace aisle inside the sarsens, the remainder closer within the trilithons.

Then stood Stonehenge in a glory of contrasting colours we fail to realize, high Temple of the Sun, focus of a system of eight good trackways radiating through the populous land that later was Wessex, centre to which all steps were bent the morn he came nearest north. Only in centuries of colonization by lichens, white, black, yellow, orange, grey and green of every shade, did all its stones alike acquire the tough crust of speckled hodden gray we know, Fig. 9.

Round it spreads a level lawn, bounded by a now slight Bank thrown in from a ditch 50 paces from the Circle (and thus of diameter identical with Stenness.) Ten paces within, round spots of chalk mark holes 1.5 p. diameter by 1 p. deep found, mostly with a handful of burnt bones in a side pocket, and now named Aubrey holes. John was a genial quiz, the Ripley of his age: granted by Charles II, at the Royal Society, a patent for antiquarian research, he grafted upon the Stones the parasitic evergreen which we now refer to a woodland cult in vogue 1,000-2,000 years later. Two smaller rings of rectangular shelving *Y* and *Z* holes, containing only chalk refill, are turfed over.

Northeast from a gap in the bank extends the strictly axial approach Avenue, bounded by slight banks thrown in from ditches dug 30 paces apart, now traced 1000 paces or more. At the gap, alongside the axis, lies the 8-pace Slaughter Stone. A local worthy, in age, claimed to have seen it standing, relict of an entrance trilithon; but old men dream dreams. Sunk nearly flush, it looks a convenient platform for the deposition of the gifts assemblies would bring in fee.

A few paces inside the bank, on a line bearing 26½° N. of W. from the centre, stands a stumpy stone, and in a corresponding position 26½° S. of E. is a companion outlier.

Finally, 100 paces from the centre, down Avenue, and 2 paces SE. off axis, Fig. 5, stands a huge rough bulgy boulder, the Friar's Heel. The Devil, they say, swindled an old Irishwoman out of these stones, and brought them overseas, and only when his building was finished did a glimmer of dawn disclose a spying friar: he sent down a fast one, but the holy man's heel stopped it and left a dent discernible unto this day. More prosaic is Hele Stone, from A.S. ***helan***, hide; or, if you prefer it, Gr. ***helios***, sun.

Stonehenge complete with its finely tooled surfaces, its mortised capstones, and its inner apse, was far in advance of any other Circle. Yet it was but a copy, as a child copies with his building blocks, of the sun temples then rising by the Nile, in the great outburst of building activity under the New Empire. Some younger son had travelled and studied there, and come back full of the latest ideas, cult, ritual and all. See how Figs. 10 and 11 do dimly recall their huge hypostyle halls. In this they differ; they were roofed, the solstitial sun-flash was the only light that ever

penetrated to the holy of holies, they provided the grateful quasi-miracle of shade in a sun-stricken land. Stonehenge never was; British midsummer sun burns up no crops, from our midsummer showers nobody would shrink, British draughts under a dripping roof—brrr!

For untold centuries the weather worked its will: count the 30 sarsens sunwise from the entrance, Fig. 8 x 2, and see the prevalence of S.W. gales. The S. pier of the great central trilithon fell in 1620, breaking itself and the altar-stone, and leaving its fellow at 65° as 'the leaning stone'; their capstone lies intact across the W. end of the altar stone, Figs. 9 and 11. The fall of the W. trilithon in 1797 was attributed to gipsy digging; it lies apparently uninjured left of centre, Figs. 8 x 2 and 9, its capstone flung to the foot of sarsen 21. Hunchback sarsen 22 and lintel rest on them, blown down in the last hours of last century. The N. pier of the north trilithon stands leaning S.; its fellow, and their capstone, are in half-a-dozen pieces.

Figs. 10 and 11 show seven still standing of the dozen surviving bluestones of the inner colonnade, and in Figs. 8 most of the remaining flatter ones (up to 3 paces high by 1½ paces broad) of the outer can be espied, standing, stumps, or fallen. Others might possibly be found still serving as barn door-sills, or gate-posts, elsewhere in this stoneless region, and fallen sarsen was of course anybody's road metal: Nos. 13, 17, 18, 20 and 24 are clean gone, and only a bit of lintel 127 lies unremoved.

In 1901 Sir Edmund Antrobus set the (cracked) Leaning Stone safely upright, Fig. 9: its toe is 3 paces underground, its 8-pace-high head bears a conspicuous tenon, its mass is 26 tons. A green stain, deep down, of bronze corrosion, gave the first and only clue to 'age'. Skyhigh rose the outcry that the owner should dare restore property that all had ever been free to wreck: but men had in mind the fell handiwork of Victorian 'restorers' inside too many churches. Seventeen years later Sir Cecil Chubb presented the monument to a nation at last awake to its value, and it has since received conservative care, shored-up stones having been cradled, underdug, straightened and reset in concrete. Old stone implements were found in abundance, all the roughest: polished stone or bronze tools would have been ephemeral toys among such stern masonry.

A tumulus, huge but low, here called a 'Round Barrow', stands close east, and a score smaller flank the S. and W. aspects at half-mile distance, exactly topping the skyline to an observer standing in the Circle, to whom signallers upon them would be completely in silhouette. Within a few miles are 300 more round barrows of a brachy-cephalic race, but only two of the long barrows, common further afield, of earlier longheads. One infers that shortheads built Stonehenge; and fine flint, pottery, bronze daggers, and gold ornaments, found accompanying interments, three out of four cremated, in these barrows, have led archaeologists to agree with the astronomical date they long loudly derided.

This was obtained January 1901 when Norman Lockyer determined, with the utmost care, the azimuth of the axial Avenue, finding it in close agreement with 49°34.3′ of a Survey line to a 'mark' on an ancient 'castle' on Sidbury Hill, 8 miles distant, height 735 feet, horizon elevation 35.5′. For latitude 51° 10.7′ this gave him sun's solstitial declination 23° 54.5′, corresponding on our Chart to 1680 B.C., with a probable error he estimated at 200 years either way.

The Friar's Heel, with its head displaced 2 paces = 1° 9′ S.E. off axis, he spurned as valueless; and astronomically it is. The ephemeris will show you that the sun's declination on the 1st, 2nd, and 3rd days from solstice, before and after, is less than its maximum by 0.2′, 0.85′ and 2.0′ only. Fig. 5 shows the azimuthal differences about double, so that for 5 days the sun moves less than 2′ on the horizon, which at 100 paces means $2' \times 100/3437' = 0.06$ pace. Thus the greatest movement demanded of the observer, to keep his sunrises exactly alike on the Friar's Heel five days running, is two inches horizontally and one inch vertically. Dad was right about the village Ring: the high astronomer of all the land would be helpless without his far away fiducial mark.

The clumsy Stone is 6 paces tall, but the gentle slope down to it past the Slaughter Stone puts half that below Circle level; then 2 paces for eye-level leaves only its sleek parabolic crown above the 0.6° raised skyline, and in Fig. 5 (from its best-known photograph) you see it skull-capped by the sun. But—see where 27′ greater declination put him 3600 years ago: 7 minutes after signal from the barrow-tops had been verified by the glance of the astronomer—now robed as Priest—"Behold the God! how he stands

as stand the gods of old Egypt, with the Sun-disc on his head!" That was the Sight of Stonehenge.

And if, as nowadays, only one solstitial dawn in three was clear —that Gulf Stream!—would those who had footed it fifty miles—? Oh no: this was no Eclipse—like 1945 July's lucky one that I'd waited vengefully 18 years for—this was a three, or even five, day meet, days of 16½ hours and short twilight nights, likely the greatest annual function in the land. As to Ceremonial: sacerdotal, masonic, convocational, judicial, political, social, etc., your guess is good as mine. Then the green turf, the Cursus, the gipsy fortune-tellers—my thoughts flit 66 miles east to another chalk down (rising above a spring once renowned for salts hereabouts reviled as white alkali), where, every first Odin's day in June, half a million resort to woo the Lady Luck, under the sign of the Centaur.

June sunset was not sighted. And though, produced backward, the axis hits ringed hill Gravely Castle, this is low and is ruled out 1° by our Chart: besides, mid-winter night on that Plain, among those eerie Stones!

But with the 26½° outliers abovementioned, Fig. 2 and an assumed 0.5° horizon (since the Circle is in a slight depression),

$$ZO = 90°13', PZO = 90° \pm 26° 30', PZ = 38° 49',$$

giving 16° 25′ N. and 16° 4′ S. declination,
which reduce by $(23° 54.5' - 23° 27')/23° 54.5' = 0.019$ part,
to 16° 6′ and 15° 45′ nowadays, and give
Feb. 5, 4h(rise), May 4, 4h(set), Aug. 10, 4h(set), Nov. 7, 0h(rise)
Spring 89, Summer 98, Autumn 88, Winter 90,
or more casually, assuming 0.7° horizon and Fig. 1
Spring 88, Summer 97, Autumn 88, Winter 92.
Compare Stenness.....Spring 88, Summer 96, Autumn 90, Winter 91.

Ample agreement for all ordinary purposes, the differences mainly due to the observations of the quick-moving sun being inevitably a whole day apart; yet leaving any absolute annual date uncertain: the new solstice cult had to supply that.

Massed sarsens block any May sunrise-November sunset line, and no outliers exist: we have seen it was not called for.

So also are our two outliers hidden from centre; they can be seen from mid-altar-stone, but that gives two lines of sight, both slewed 5° northward.

Some consider them relics of an earlier circle: whence came their companions, and whither dispersed, left unconsidered. I am tickled to think them dumped in by a disgruntled astronomer, on the insistence of stubborn roundheads of the old school, who were great cultivators. He met his match: A stood mid-circle and B by the outlier; both, facing Gravely Castle, took three paces forward, and were then in sight of each other: eyes right or left, AB was the true sightline.

Figures 8, 10, 11 are from photographs of a sixteenth-inch model of the familiar old place, which, sifting all sources available here in Saskatchewan, I built with meticulous care, as the only means of making it clear to anyone. The outer greensward is reduced in scale by one-fourth. Figs. 8 x 2 and 10 x 2 are central enlargements.

In Fig. 8 the main solstitial sightline is a cord stretched at eye-level, clearing the Great Stone by half-shoulder-width, and the peak of the Friar's Heel by two paces. The skew sightline cord crosses it three paces short of circle centre, its ends have been dipped to ground level to show it clear of this side of the outliers, its ground-shadow is perfectly straight on the negative. It would pass through a restored W. trilithon.

Fig. 9 is one of five recent photographs by Lt. Ian Fiddes which settled several doubtful points. The bystander appears in the same place, and to scale, in the other three pictures.

In conclusion: when next you cross the Atlantic, pray you, in opening June, visit 'New Sarum', for the first great fane of the united English, then the hilltop of its predecessor, and then—

'Tis glowing, that Plain of Old Sarum, in the Isle of the Sons of the Sea,
Red- and blue-sprinkled with Milkwort, with Thyme for the tongue of the Bee;
Place of the Dawn of the Solstice, that men from afar came to view;
Place of the dawning of History, in a Land that has tried to be true.

There stand the giant Trilithons, overawing the turbulent throng,
Ringed round about by their Sarsens, brought hither with toil and with song;
With gifts of the Earth and her bounty, with gifts of the chase and the loom,
Mid-centre of joyous Assembly, high Circle of dread and of doom.

You count out your years by the thousand; six score generations of men
Since you have been scanning the Heavens; since you have invented the Pen
And turned home to sleep in your grassland at the close of their life's brief day:
Old Shrine of Long Ages of Worship; we cherish you, even as they!

And the next year, journey westward, to the beautiful Yosemite, and up into the Mariposa or other grove of the Sequoias of the Sierra, and standing beneath some grizzled veteran, still in frond and still in cone, sense him calling across the world—"Ah! when you young couples were setting up house, and I was a sapling scarce six times your height—"

The Society has, at 3 Willcocks St., Toronto, a number of the penny 4-page official leaflets of Stonehenge, and one will be returned, while they last, on receipt of a self-addressed envelope marked with a circle and stamped 1 cent.

Observatory of the University of Saskatchewan,
Saskatoon, June 11, 1946.

SWEEPING THE SKIES FROM STROMLO*

By Len Barsdell

DOMINATING a ridge of hills about seven miles from Canberra, Federal Capital of Australia, is a pine-covered peak known as Mount Stromlo.

There is nothing very unusual about this mountain. Its rugged slopes are camouflaged with pines and a few stunted gums, and in general appearance it looks like any other rise in this country of ranges and ridges—except, perhaps, for its summit which is flat and rectangular.

Here, some 2650 feet above sea level is a compact group of buildings that comprise the Commonwealth of Australia Observatory.

Located about 100 miles from the coast in the centre of an Australian forestry reserve, Mount Stromlo offers unique opportunities for solar research. It is free from the glare of city lights and the grit and smoke haze of industrial areas, and its position enables scientists to have a clear, unobstructed view of the heavens.

This freedom from glare and haze is essential to present-day accuracy. For this reason, therefore, Greenwich Observatory, which has calculated the world's time since 1675, is to be moved east to Hurstmonceaux Castle, Sussex. The change is being made, according to an official statement, because London's smoke and bright lights at night are interfering with astronomers' observations.

Mount Stromlo Observatory, begun in 1923, completes a chain of such institutions around the world. Apart from the benefits Australia derives from the work of this Observatory, its importance lies in the fact that scientists can now keep the sun continuously under observation.

Study of the sun and its influence on the ionosphere—a belt around the earth of varying characteristics, vitally important in short-wave radio transmission—is an essential phase of the observatory's work.

The programme is long, involving endless calculation and collection of data, and it is an accepted fact that the Australian Observa-

*This article was supplied through the kindness of the High Commissioner for the Commonwealth of Australia, in Ottawa, Canada.

tory has the longest series of automatic records of the ionosphere, (one every 15 minutes) in the world.

During the war information about this work was of necessity strictly 'off the record,' but it can now be revealed that statistics passed on to the Services proved of incalculable value.

Ironically enough, the impetus of war speeded the development of the Observatory, which, until 1939 existed with a skeleton staff for one purpose only—the study of the sun.

To-day, the Australian Observatory is pursuing the whole field of astronomical research, in addition to which it provides Australia with an accurate time service.

The idea of forming an institution for the study of the southern heavens was first mooted in 1907, but it was not until three years later that the Mount Stromlo site was selected. Investigations were conducted in many parts of Australia and covered thousands of miles of territory. It was generally conceded that of all the places inspected Mount Stromlo offered possibilities eclipsing all others. It had the necessary altitude and distance from the sea, good building sites, and a water supply to suit all needs.

In 1911 a temporary observatory was erected "high up among the rocks and lizards, miles from anywhere," according to an early report of the mountain top, and the Government Astronomer of Victoria was deputed to test the suitability of the site. After two years' observations he reported favourably.

In March, 1914, the Administrator of the Federal Territory foreshadowed the erection of an up-to-date observatory at Mount Stromlo at a cost of $900,000, with annual running costs of about $72,000.

This gave rise to much favourable comment and some criticism.

A small but vocal minority expressed the fear that too much attention towards the astronomical field might lead to a cult of star-gazers.

Others, more practical, suggested the proposed observatory might be able to advise farmers 14 days ahead of weather conditions and approaching floods so that they could get their stock to higher ground.

The more cynical, however, recalling that the Observatory was seven miles from the site for the Federal House of Parliament, asked what influence sun-spots might have on the rise and fall of govern-

ments, and suggested this might furnish an obscure and fascinating field of research.

Despite this cross-section of opinion, it was generally recognized that an Australian Observatory would benefit not only Australia but the world of science.

Interest was heightened by the announcement that members of the British Association for the Advancement of Science, some of

Fig. 1.—A birdseye view of the Australian Federal Observatory on Mount Stromlo, showing it almost surrounded by a forestry reserve of pines. Stunted gums (Eucalypts) are shown in the immediate foreground and in the background of ridges and plains. Mount Stromlo is ideally suited for an observatory. It is free from the glare of city lights and the grit and smoke haze of industrial areas, and its position enables scientists to have a clear, unobstructed view of the heavens. Mount Stromlo completes a chain of such institutions around the world.

whom were astronomers, would visit Australia in August, 1914 to advise upon the possibilities of solar research.

Unfortunately, 1914 was to be a fateful year for Australia and the world. The British delegation arrived shortly after the outbreak of

the first world war to find Australia preparing to assist Britain in resisting the enemy.

Undaunted, the visiting scientists, who included the Astronomer Royal (Sir Frank Dyson), Sir Oliver Lodge, and the Director of the Astrophysical Observatory at Washington, D.C. (Dr. C. G. Abbot), waited on the Prime Minister, Mr. (later Sir) Joseph Cook, and emphasized the need for an observatory in Australia to cover the magnificent field of southern stars, which still awaited investigation from the astrophysical point of view.

But neither public opinion nor the persuasive powers of the visiting scientists influenced the government. Australia was at war and money was needed for more urgent purposes.

Both Britain and America, however, continued to advocate an observatory in the Southern Hemisphere to link up with a chain of stations covering the northern field.

With the end of the war in November, 1918, the Lick Observatory of America made representations to establish its own research station in Australia, and sent out Professor Hussey to make preliminary investigations. He tentatively selected a site at the Canobalas Range at Orange, some 200 miles west of Sydney.

His visit prompted certain amateur astronomers to suggest that Australia might assist America to build an observatory here. Nothing happened. The years were passing and still Australia had no solar observatory.

In 1923 the observers on Mount Wilson, California, spoke of the need for a properly equipped solar observatory in Australia. The establishment of such an institution, they said, was of paramount importance because it would enable the sun to be kept continuously under observation, which at that time was impossible.

It was an Australian-born physicist, Professor Geoffrey Duffield, who held a Chair of Physics at Reading, England, who eventually turned the tide. His persistent advocacy decided the issue, and in that year the Australian Government agreed to reserve Mount Stromlo for an observatory. The Lick Observatory thereupon abandoned its plans for active research work in Australia. A committee of British astronomers, invited to appoint a director, chose Professor Duffield, who assumed his duties on January 1, 1924.

High hopes were held for the success of the institution. Until

then Mount Stromlo had been used almost solely as a look-out station for bush fires in the summer months. Henceforth, it was explained, scientists would use the mountain top as a look-out for the study of solar phenomena and spectroscopic research, and for the investigation of associated terrestrial phenomena. The project received the support of the British association for the Advancement of Science, the International Solar Union, and scientific bodies in America, India and Europe.

Fig. 2.—The Australian Federal Observatory and administrative buildings.

Professor Duffield, in his initial report on January 2, 1925, said:

> As large a portion as possible of the apparatus required for the new instruments should be made in Australia. It is my earnest desire that we should take our place among the great observatories of the world.
>
> It is even possible that we may lay the foundation of a lens-making industry in Australia. This might have far-reaching importance in the event of our ever becoming isolated, and the men trained in our works might ultimately develop an industry which would make periscopes for submarines, range-finders, theodolites, field glasses, etc.

Such foresight! It was 15 years before the effect of Professor Duffield's statement bore fruit. Neglected until the beginning of

World War 2, the Australian Observatory's rise to prominence has since been rapid.

In 1940 optical work could not be done in Australia; even raw optical glass had to be imported. An optical munitions plant was established at the observatory during the war years and produced optical instruments equal to the best imported articles. These included prisms and lenses for all types of war instruments, periscopes, dial-sights, binoculars, telescopes, air sextants—all manufactured in Mount Stromlo's workshops with the precision of age-old craftsmanship.

Another phase of the Observatory's work to-day is providing Australia with an accurate time service. The determining of time is a very practical side of astronomy. Indeed, the principal observatory in the British Empire—the Royal Observatory at Greenwich, near London—was founded by Charles II in 1675 for the practical purpose of navigation, and to this day is maintained by the British Admiralty. Similarly, there is in Washington, D.C., the United States Naval Observatory. For the same purpose—that is, to assist shipping—observatories were founded early in Australia's history at Adelaide, Melbourne and Sydney, and were maintained by their respective State Governments.

The various Australian States, with the exception of Victoria, still maintain their own observatories, but the work of the Melbourne Observatory has now been taken over by the Australian Observatory at Mount Stromlo, which, with the advantage of Australia's clear skies, has organized a time service comparable to those maintained by the great nations of the world.

Every day the quartz clocks of the Postmaster-General's Department are put through on the land-line to Mount Stromlo and the "pips" recorded on a tape on which is also super-imposed observatory time. Margin of error is measured and then reported back to the P.M.G. Time accurate to 1/100th of a second is provided by clocks formerly used by the Melbourne Observatory, but even this is not enough. The P.M.G.'s Department wants accuracy to 1/1000th of a second so that radio frequency control, requiring the utmost precision, can be maintained in narrow bands without overlap. Such accuracy is still beyond the power of astronomy.

The Observatory's work, quiescent until the beginning of World

War 2, was revolutionized and accelerated by the appointment of Dr. Richard van der Reit Woolley as Commonwealth Astronomer in 1939. This brilliant scientist has an international reputation as a writer on astrophysics. After studying at Capetown University, Dr. Woolley became a pupil of Sir Arthur Eddington, senior lecturer at Cambridge University's solar physics observatory. There he won

Fig. 3.—The Observatory's largest telescope—the Reynolds 30-inch reflector.

a two-year scholarship which entitled him to study at Mount Wilson Observatory, California. After Mount Wilson he became Chief Assistant to the Astronomer Royal, Dr. Spencer Jones, at Greenwich Observatory. Under Dr. Woolley's inspiring leadership, the Australian Observatory is taking its rightful place in the world of astronomy. With a competent staff and modern workshops the promise of new and essential equipment, the Australian Observatory's future looks bright.

TERCENTENARY OF JOHN FLAMSTEED (1646-1719)*

By Sir Harold Spencer Jones, F.R.S.

Astronomer Royal

TO-DAY [August 18] we commemorate the tercentenary of the birth of John Flamsteed, the first Astronomer Royal and one of the greatest practical astronomers of his day. I am glad to have the opportunity to pay a tribute to the first of my predecessors, who laboured with single-minded devotion at Greenwich for forty-four years. It is appropriate that this commemoration should be held in this church: for Flamsteed held the living of Burstow for thirty-five years, he paid frequent visits here, and in the chancel of this church he lies buried.

John Flamsteed was born at the village of Denby, several miles northward from Derby, on August 19, 1646. His parents were, in his own words, "of known integrity, honesty and fortune, as they were of equal extraction and ingenuity". When barely three years old he lost his mother, his father being left with the care of a daughter, then not a month old, and of John, who was a child of a weakly constitution. He was educated at the free school of Derby, where his father lived. At the age of fourteen, he contracted severe rheumatic trouble, as a result of river-side bathing. The effects of this he felt throughout his life; he suffered from perpetual ill-health, "my distemper" as he called it. He became so weak that he was scarcely able to go to school and, when not quite sixteen years old, he left school for good. At school his studies had consisted largely of history and Latin. Being lent a copy of Sacrobosco's "Spheres" in Latin he soon began to show an inclination towards mathematics and astronomy, while his father taught him arithmetic. He observed and recorded an eclipse of the sun and learned how to predict eclipses and to calculate the places of the sun. His practical inclinations were shown in the construction of dials and of a quadrant and in grinding lenses for telescopes.

Self-taught by dint of assiduous reading and study, Flamsteed acquired a wide knowledge of astronomy. His observations, made

*Substance of an address delivered at a tercentenary service held in Burstow Parish Church on Sunday, August 18. Printed in *Nature* for August 31, 1946, and reprinted in this Journal with the author's cordial permission.

with a small telescope, showed him how deficient were the current astronomical tables. In 1669 he calculated some occulations of stars by the moon for the year 1670, which were transmitted by a friend to Lord Brouncker, the president of the Royal Society. This brought Flamsteed into communication with Oldenburg, the secretary of the Society, and with John Collins, a fellow of the Society, who maintained an extensive correspondence with Newton, Gregory and other prominent fellows.

In 1670 Flamsteed, at his father's suggestion, went to London to become personally acquainted with his learned correspondents. He visited Oldenburg and Collins, who took him to the Tower to meet Sir Jonas Moore, The Surveyor-General of the Ordnance, a mathematician and a fellow of the Royal Society. This was an important event in Flamsteed's life, for Sir Jonas Moore took a great interest in the young astronomer, and became his warm friend and patron: to his help and encouragement Flamsteed owed a great deal. Later in 1670 Flamsteed entered himself at Jesus College, Cambridge, and in 1674 he took the M.A. degree. While in Cambridge he made the acquaintance of Dr. Barrow and Mr. Newton.

Flamsteed spent some part of his time in astrological studies, as was not uncommon at that time. But in 1673 he wrote an ephemeris wherein he "showed the falsity of astrology and the ignorance of those who pretended to it". At Sir Jonas Moore's suggestion, he prepared an account of the tides for King Charles II. He also constructed a barometer (a "weather glass" as he called it) and afterwards gave one to Sir Jonas Moore; he, in turn, presented weather glasses to the King and the Duke of York, giving them also the directions which Flamsteed had prepared for judging the weather from their rise or fall. This, Flamsteed records, brought him "more than ordinary regards from them".

Sir Jonas Moore had shown his interest in Flamsteed in a practical way by offering to pay £10 a year and to obtain a further £10 from two friends, for the employment of an assistant to help him with his observations and computations. On taking his degree, Flamsteed designed to take orders and to settle in a small living near Derby, which was in the gift of a friend of his father. From his early years he had been of a very pious and religious turn of mind. In 1675 he took orders at Ely House, at the hands of Bishop Gunning.

Flamsteed, in the account of his life, says "My desires have always been for learning and divinity; and although I have been accidentally put from it by God's providence, yet I have always thought myself more qualified for it than for any other employment; because my bodily weakness will not permit me action and my mind has always been fitted for the contemplation of God and his works".

Plans were at this time under discussion for founding an observatory in London, under the auspices of the Royal Society. Sir Jonas Moore was greatly interested in this project and invited Flamsteed to London to consult him on the subject. He resided at Sir Jonas Moore's house in the Tower, where he carried on his astronomical observations. But while this scheme was under consideration, the event happened which definitely turned Flamsteed's life into a new direction.

At this time there was no satisfactory method of finding the longitude of a ship at sea. The need for a reliable method had become urgent. The proposal had been made that the longitude should be found by comparing the position of the moon (got by observing her distance from the fixed stars) with her place given by astronomical tables. A Commission, which included Lord Brouncker, the principal officer at the Navy Board, Sir Jonas Moore, and Flamsteed, was set up to report on the plan. The Commission reported (Flamsteed tells us) that this method was indeed the most likely to prove useful to our sailors because most practicable; but that the catalogue of fixed stars was both erroneous and incomplete; that the best tables of the moon's motions were inaccurate; and that these errors would sometimes cause an error of three hundred leagues in the determination of the longitude; so that our sailors could expect no help from this method till both the places of the fixed stars were rectified, and new tables of the moon's motion made, that might represent her place in the heavens to some tolerable degree of exactness; for which a large stock of very accurate observations, continued for some years, was altogether requisite, but wanting. That therefore His Majesty would give a great and altogether necessary encouragement to our navigation and commerce (the strength and wealth of our nation) if he would cause an observatory to be built, furnished with proper instruments, and persons skilful in mathematics, especially astronomy, to be employed in it, to take new observations of the heavens, both of the fixed stars and planets, in order to correct their places and motions, the moon's

especially; that so no help might be wanting to our sailors for correcting their sea charts, or finding the places of their ships at sea.

When the report was shown to the King, he, startled at the assertion of the fixed stars' places being false in the calalogue, said, with some vehemence, "He must have them anew observed, examined and corrected, for the use of his seamen"; and further, when it was urged to him how necessary it was to have a good stock of observations taken for correcting the motions of the moon and planets, with the same earnestness "he must have it done". And when he was asked who could, or who should, do it, "The person (says he) that informs you of them." The outcome was that Charles II decided to found an observatory and Flamsteed was appointed to take charge of it. Chelsea and Hyde Park were considered as possible sites, but in the end, at the suggestion of Sir Christopher Wren, Greenwich was chosen, Charles II giving a site on the highest ground in the Royal Park at Greenwich. Wren was appointed architect of the observatory, which was built at a cost of £520, defrayed by the sale of old and decayed gunpowder. The foundations were laid in August 1675 and the building was completed by July 1676. Flamsteed was appointed, in the terms of the Royal Warrant, "our astronomical observator" (the designation Astronomer Royal was given at a later date: Flamsteed usually signed his name as M.R.—Mathematicus Regius).

He was granted an allowance of £100 a year; from which £10 was deducted as tax. Inadequate as this was, it was often in arrears. Although the Committee had recommended that the observatory should be provided with proper instruments and with skilled persons to observe with them, no instruments were, in fact, ever provided by the Government and the only assistance given was that of a common labourer. Flamsteed's patron, Sir Jonas Moore, generously presented him with a large iron sextant and two clocks by Tompion, the most celebrated maker of clocks of the day. He borrowed also a small quadrant from the Royal Society, but on the death of Sir Jonas Moore, this was called back.

With the sextant it was possible to observe only the relative positions of the stars. An instrument fixed in the meridian was required to determine their absolute positions. Until such an instrument was provided it was not possible for him to achieve the practical ends for which the observatory had been established. Flamsteed made repeated applications to the Government for a mural arc; it was often promised,

but it never came. In 1681 he therefore had a mural arc made at his own expense, but it proved to be not sufficiently rigid in construction, and the observations made with it were not of the accuracy that was needed. In 1684 Lord Keeper North presented him with the living of Burstow; soon afterwards his father died and Flamsteed, finding his income somewhat increased, decided to construct a new mural arc, much stronger than the former. This was completed in 1689, at a cost of upwards of £120. The Master of the Ordnance had promised that the cost should be repaid to him; but the promise was not kept and not a farthing of the money he had expended was ever refunded to him.

The tasks that Flamsteed had undertaken were Herculean. They were, first, the construction of a catalogue of the fixed stars, more extensive and more precise than all existing ones; secondly, the systematic observation of the sun, moon and planets with the view to revising the theories of their apparent motions and to constructing tables from which their positions could be computed with the desired accuracy. These tasks were far beyond the capacity of one man, for they involved not merely continuity and regularity of observation over many years, but also extensive computations. It was essential for Flamsteed to have assistance; as none was provided by the Government, he had to defray the cost out of his own pocket. To meet his expenses, it then became necessary for him to take private pupils for instruction in mathematics and astronomy. An additional burden was put upon him by the King who ordered him to instruct two boys monthly from Christ Church Hospital in mathematics. These calls on his time necessarily distracted him from carrying on his astronomical observations with the expedition that he desired. In 1710 Flamsteed stated that he had spent upwards of £2,000 above his salary in furnishing instruments and in hiring assistants and computers.

Under such disheartening conditions and with his persistent ill-health, it was surprising that Flamsteed was able to accomplish so much. His observations were planned with a careful attention to accuracy in their most minute details; he introduced new methods into practical astronomy, many of which are in use to-day; an immense mass of computations were carried out in a systematic and orderly manner, to correct the theories and to improve the tables of the sun, moon and planets, and to elucidate intricate points in practice and

theory. He established the fundamental essentials of practical astronomy on sure foundations, which served as a landmark for his successors. In accuracy his observations far exceeded those of his predecessors or contemporaries; they are, in fact, the earliest observations from which the phenomenon of aberration is clearly deducible. In addition he maintained an extensive correspondence with the principal astronomers and scientists of his day.

Flamsteed had realized more clearly than any of his contemporaries that a large stock of accurate observations, continued for many years, was needed to accomplish the tasks on which he was engaged. But it was not long before demands began to be pressed upon him for the publication of his results.

These demands Flamsteed resisted, claiming the right to decide for himself when his results were sufficiently complete and accurate to justify publication. This question of publication was to involve Flamsteed in acute controversies with Newton and Halley, which embittered the later years of his life. For some years Flamsteed and Newton maintained a friendly correspondence and Newton often visited the observatory. Flamsteed had a high regard for Newton; he said that "Mr. Newton's approbation is more to me than the cry of all the ignorant in the world". Newton was occupied at this time with the theory of the motions of the moon; he made frequent requests for Flamsteed's observations and at various times asked him to make observations at certain specified periods. Flamsteed complied with all these requests; he seems, however, to have resented that Newton "was too inconsiderate as to presume he had a right to that which was only a courtesy" and that "he said not one word of his obligations or debt to the Royal Observatory". The relations between the two men gradually became cooler and eventually widened into an open breach.

At length Flamsteed began to consider the question of publication of his observations and of his great catalogue of stars. He planned to bring out a single great work, which would be a monument to his industry and skill, and would raise the name of England in the astronomical and scientific world. He prepared an estimate of the number of pages; but at this juncture, Prince George, consort of Queen Anne, having learnt of Flamsteed's labours, proposed to have the work printed at his own expense. A body of referees which included Newton, then president of the Royal Society, was appointed to inspect

Flamsteed's papers; this was done, and it was recommended that all should be printed. Flamsteed was instructed to hand over a copy of his observations and of his catalogue; but as the catalogue was incomplete and imperfect, he deposited a sealed copy, not for printing but as a guarantee of furnishing a revised and completed copy at a future date. The printing proceeded very slowly and the first volume alone had been completed by 1708, when Prince George died. In 1711 the printing was resumed by order of Queen Anne, but unknown to Flamsteed; a garbled and incorrect edition of the observations with the mural arc and of the imperfect and incomplete catalogue, which had been deposited under seal, was published in 1712 without Flamsteed's consent. It is not surprising that this unauthorized publication was deeply resented by Flamsteed.

A further source of trouble to Flamsteed was the appointment in 1710 of a Board of Visitors of the Observatory with power to demand from Flamsteed each year a true and fair copy of his observations. For Flamsteed, not without reason, looked upon the observations as his own property. It must be remembered that the instruments with which they were made were his own; "the very books in which these observations were entered, the pens and the ink with which they were written, the paper on which they were copied, were all furnished at his own cost, and not at the expense of the public, who contributed nothing but his paltry salary". This question of the proprietorship of the observations made at the Royal Observatory came up in 1762, on the death of Bradley, the third Astronomer Royal. Bradley's executors took possession of his observations and maintained their right to them in a lengthy lawsuit brought by the Crown, even though Bradley was supplied with instruments of the best sort at the public expense and, moreover, had an addition of £250 per annum to his salary. With how much greater right did Flamsteed then regard his observations as his own property!

Flamsteed resolved to publish a correct version of his observations and of his catalogue at his own expense. With this end in view he applied to Newton for the return of the manuscript copy of the catalogue and of 175 sheets of observations. Being unable to secure them, he was compelled to recopy them all for the press at an expense of nearly £200.

Whilst engaged on this work Queen Anne died, there was a change of ministry, and people more friendly to Flamsteed came into power. He was able to secure three hundred out of the four hundred copies

of the garbled and incorrect volume that had been printed and he publicly burnt them "as a sacrifice to heavenly truth". He then began printing a revised edition at his own expense, but he did not live to finish the task. In 1719 he died before the printing was nearly completed. It was finished and published in 1725 by the devoted labours of Crosthwait and Sharp, who had been Flamsteed's private assistants.

The "Historia Cœlestis Britannica", in three volumes, containing Flamsteed's observations and his great catalogue of nearly three thousand stars, was the first important contribution to science given by Greenwich Observatory to the world. It opened a new era in sidereal astronomy and stands as an enduring monument to Flamsteed's scrupulous care and unflagging industry and to what he was able to achieve in his forty-four years at the Royal Observatory, in the face of official neglect and very great difficulties. The injustice with which Flamsteed had been treated in his life did not end at his death. The Office of Ordnance attempted to prevent his executors from removing his instruments from the observatory and brought a lawsuit against them; but, as the executors were able to prove that the Office had never paid for any of the instruments, nor even for their repair, the case could not be sustained.

Flamsteed was a man of singular piety; his diaries and letters abound with devout expressions of thankfulness to God. Suffering from continual ill-health, denied the official support which he was entitled to expect, unjustly treated by those who did not appreciate the difficulties with which he had to contend, it is not to be wondered at that in his later years he became embittered. His unwearied perseverance in the face of difficulties and his single-minded devotion to his duties laid the foundations upon which the pre-eminence of the Royal Observatory among the institutions devoted to practical astronomy has been built. He realized better than any of his contemporaries what was most needed in his day for the promotion of astronomy. His work was marked by no brilliant discoveries; but, by unflagging industry and scrupulous care, by systematic observations and insistence upon accuracy, he bequeathed to his successors an immense treasure of observations. His name will always be honoured as that of the first great British observer who established precise astronomy upon secure foundations, and is enrolled among those who have made permanent contributions to the advancement of astronomy.

OUT OF OLD BOOKS

By Helen Sawyer Hogg

Absence of Aurorae in the Seventeenth Century

LAST month we reprinted an article by Maunder in the August issue of Knowledge, 1894, describing the amazing dearth of sunspots during the latter half of the seventeenth century. In the September 1894 issue of the same magazine, Agnes Clerke replies to this article by noting the absence of aurorae during the same period. We quote her letter to the Editor, as well as excerpts from a more detailed account of this phenomenon from the *Edinburgh Review*.

From *Knowledge*, volume 17, page 206.

A Prolonged Sun-Spot Minimum

To the Editor of Knowledge.

Dear Sir,- The partial suspension of solar activity established by Mr. Maunder in his article entitled as above (Knowledge, August, 1894), represents a curious phase of solar history. There is, besides, strong, although indirect evidence that the "prolonged sun-spot minimum was attended by a profound magnetic calm. This evidence is to be found in the auroral records of the time. For the connection between the occurrence of aurorae and the magnetic conditions of the earth is so close, that the absence of one kind of disturbance may safely be held to betoken the absence of the other.

Now in England, during the whole of the seventeenth century, not an auroral glimmer was chronicled. Stowe recounts that on the 14th and 15th of November, 1574, "the heavens from all parts did seem to burn marvellous ragingly"; and the next similar occurrence took place on March 17th, 1716. Upon his observations of this fine display, Halley founded his magnetic theory of aurorae. The event created an extraordinary sensation throughout the country, some slight and partial sky-illuminations in 1706 and 1709 having escaped general notice.

On the Continent, the auroral blank was much less complete than in this country. Gassendi's aurora of September 12th, 1621, was seen as far south as Aleppo; Cromerus registered the passage of "whole armies" across the sky in 1629; in 1640, south polar lights were visible in Chili every night of February and March, and some corresponding appearances were noted in northern latitudes. By the middle of the century, however, polar lights had virtually died out everywhere, except perhaps in northern Scotland, where the "merry dancers" were seen without surprise in 1691. But even in Iceland and Norway they became so rare as to be considered portentous, and their reappearance at Copenhagen in 1709 was

greeted with consternation and amazement. De Mairan, in his "Traité de l'Aurore Boréale," makes the curious remark that a great extension of the zodiacal light attended the auroral outburst of 1716.

As regards the solar corona during the "prolonged minimum," it appears probable that (as Mr. Maunder suggests) its radiated structure was in abeyance, but there is positive proof that the inner corona maintained at least its average brightness in 1666. The partial solar eclipse of June 22nd in that year, being viewed through Boyle's sixty-foot telescope by Hooke, Pope (Professor of Astronomy in Gresham College), and others, "there was perceived a little of the limb of the moon without the disc of the sun, which seemed to some of the observers to come from some shining atmosphere about the body of either the sun or moon."

Yours faithfully
Agnes M. Clerke

From *The Edinburgh Review,* Oct. 1886, p. 416.

Under the designation 'Aurora Borealis' Gassendi included, in 1621, the luminous appearances vaguely and variously described by ancient and mediæval writers as 'chasmata', 'trabes', 'faces', 'capra saltans', 'draco volans', etc. The bestowal of the name was in itself no slight help towards a better understanding of the phenomenon. No longer a mere portent, it assumed thenceforward the character of a scientific problem. Curiosity on the subject largely superseded fear. Above all, some degree of distinctness was introduced into ideas about it, and accounts of its apparitions grew less bewildered; the older records often leaving it profoundly uncertain whether they refer to auroral arches and streamers, to comets, brilliant meteors, or even to conspicuous manifestations of the Zodiacal Light.

In general, however, we are safe in giving an auroral interpretation to the chronicled spectral battles, when

'Fierce fiery warriors fought upon the clouds,
In ranks, and squadrons, and right form of war',

such as were widely seen during the disastrous Cimbrian campaign of 113 B.C.; again at Rome,

'A little ere the mightiest Julius fell';

and such as Josephus describes among the presages of the destruction of Jerusalem.

Celestial conflagrations, too, may be unhesitatingly set down to the same cause. In 450 A.D., just before the irruption of Attila into Italy, the sky (Isidore of Seville narrates) 'turned red, as if with fire or blood;' and a 'blazing of the 'heavens' was quite a common sight in the following century, when St. Gregory of Tours wrote his 'Historia Francorum.' The illusion, indeed, has sometimes been complete. Thus, in the region of Tiberius, the cohorts hastened to the relief of Ostia, believed to be a prey to actual flames from the lurid glow hanging over it (Seneca, *Quaest. Nat.*, l'b. i, cap. xv); bodies of firemen were called out under similar circumstances in Paris, September 28, 1827; and in the rural parts of England, the crimson aurora of October 24, 1870, was explained as the reflection of a vast Prussian bonfire fed by the beleaguered French capital.

In Ireland, such fires turn to streams of blood. The slain at Balaklava were supposed, by the inhabitants of Berehaven, in the county of Cork, to have provided a show of northern lights visible in the autumn of 1854; and French blood flowed similarly, it was thought, in 1870. So that there is some reason for holding a red aurora to be commemorated in the shower of blood (lasting, according to one authority, three days and three nights) which celebrated the battle of 690 A.D. between the septs of Leinster and Ossory. The omen was emphasized by the sanguine hue assumed by butter, and by the human utterances of a wolf.

Not all antique 'showers of blood' can, it is true, be identified as aurorae. Abnormal rains were, in those days, too frequent and too fantastically various for profitable enquiry as to the grain of fact they conceal. Meteoric falls, luminous appearances, with aqueous showers tinged red by the presence of a microscopic alga (Palmella prodigiosa), have each a share which it would usually be mere waste of time to attempt to apportion. The bloody dews, however, by which Zeus celebrated the death of Sarpedon and the combat of Heracles with the robber Cycnus, may probably be referred to the last class of phenomena; nor is there to be found in any of the poems attributed to Homer and Hesiod a genuine vestige of an auroral reminiscence.

The first mention of an aurora borealis in England is by Matthew of Westminster, who states that in the year 555 A.D. 'an appearance as if of lances was seen in the air,' extending from the north as far as the west. Similar entries recur with tolerable frequency in the 'Anglo-Saxon Chronicles' and the 'Chronicum Scotorum.' A wider survey of such records shows them to be distributed with curious inequality over the centuries they embrace. No caprices of ignorance or unobservance will account for such wide intervals of scarity as Professor Hermann Fritz's great Catalogue of aurorae discloses. Fluctuations are obvious in the phenomenon itself, by which, during certain periods, it died down almost to extinction in Central Europe; then by its sudden revival astounded an unaccustomed generation. One of the longest and best authenticated of these pauses occurred in the seventeenth century. It is a remarkable fact that during its course not a single aurora was witnessed in any part of England, notwithstanding the keen watch kept by the Baconian philosophers of the Royal Society. The intermission (with one trifling exception in 1709) lasted, indeed, 142 years. On the night of October 7, 1574, 'burning spears' appeared above London; and on November 14 and 15 following, Stow relates that 'divers strange impressions of fire and smoke were seen in the air,' and that 'the heavens from all parts did seem to burn marvellous ragingly.' The ensuing prolonged silence as to such phenomena was at last broken by the clamour of mingled wonder, awe, and admiration which greeted the resumption of auroral activity on March 17, 1716. Halley, afterwards Astronomer-Royal, communicated to the Royal Society a detailed account of this fine display, an extract from which we here, with slight abbreviation, insert. . . .

'Many compared it to the concave of the great cupola of St. Paul's church, distinguished with streaks alternately light and obscure, and having in the midst a space less bright than the rest, resembling the lantern; and some there were that thought it liker to that tremulous light which is cast against a ceiling by the beams

of the sun, reflected from the surface of water in a basin that's a little shaken; whose reciprocal vibrating motion it very much imitated. . . .'

In a time of civil disturbance, the sensation created by these uncommon appearances inevitably took a party tinge, and Whigs and Tories divided over the aurora as they wrangled over Dr. Sacheverell and the peace of Utrecht. The Jacobites muttered that such portents boded no good to the new dynasty. They talked of giants with flaming swords, fiery dragons embattled armies; the more imaginative, or the more rebellious, averring that they had heard the report of fire arms, and smelt the powder burnt by the spectral combatants. The cue of the Hanoverians, on the other hand, was to make light of the whole affair a mere natural phenomenon. The 'Flying Post,' remarking that 'the disaffected party have worked this up to a prodigy, and interpret it to favour their cause,' proceeded to write it down to the level of sulphurous exhalations, kindled vapours, and will-o'-the-wisp coruscations from the fens!

It proved, however, to be no transient appearance, this 'Great Amazing Light in the North' (as the almanacs called it). Its frequency is vouched for by a tract published in 1741 with the title: 'An O-Yes, from the Court of Heaven to the Northern Nations, by the Streaming Lights that have appeared of late years in the Air; or Mathematical Reasons, showing that the said Lights are no less than Supernatural,' In the Lowlands of Scotland the name they long went by, of 'Lord Derwentwater's Lights,' served at the same time to mark their previous unfamiliarity and to recall their occurrence on the eve of the execution of the rebel lords Derwentwater and Kenmure, February 23, 1716.

On the Continent, during the seventeenth century, displays of the kind were scarce, but not unknown. That witnessed by Gassendi, September 12, 1621, extended as far south as Aleppo; 'whole armies' according to Cromerus, traversed the sky, December 16, 1629; Cassini observed aurorae several times in Paris early in July 1687; and Horrebow, about the same period, saw one at Copenhagen. Yet it is significant of the rarity of the phenomenon that he saw it then for the first time; and Descartes, although he lived twenty years (1629-49) in Holland, and paid special attention to all meteoric appearances, never saw it at all.

Towards the close of the century polar lights almost disappeared from all parts of the world accessible to scientific enquiries. They still glimmered here and there in the far north, but their old intensity was gone. Even in Iceland they grew by scarcity to be prodigious. On their brilliant apparition at Copenhagen in 1709, the guard turned out under arms in readiness for some imminent catastrophe; their revival was greeted in St. Petersburg with stupefaction; at Bologna, they were supposed to have been unknown until 1723. Aurorae seen in China in 1718, 1719, and 1722, excited so much amazement, that engravings of them were struck off in thousands and were secretly (portents being contraband inside the Great Wall) diffused throughout the Empire.

The next prolonged period of scarcity began in 1794, and lasted a third of a century. Since 1827, aurorae have been frequent and splendid in these latitudes, with occasional extensions to tropical, and sympathetic responses from austral regions.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Solar Eclipse Expeditions to Brazil

Brown University News Bureau has supplied the following information about plans for observing the coming total solar eclipse in South America.

Brown University and the Skyscrapers, Rhode Island astronomical organization, will jointly sponsor an expedition to Brazil to observe the total eclipse of the sun which will occur May 20, 1947.

The party of eight making the trip are all experienced eclipse observers and will be led by Professor Charles H. Smiley, director of Brown's University's Ladd Observatory. The expedition will leave Providence about April 1, and will journey by ship to Rio de Janeiro from which point they will proceed over-land to Araxa, which is located in the state of Minas Geraes about 300 miles north-west of Rio de Janeiro.

Araxa has been chosen as an observation point for several reasons. It lies directly in the path of the eclipse which will sweep north-east across the continent of South America from southern Chile to north-western Brazil. Araxa is especially suitable because of its altitude and distance from the coast which make chances for clear skies better. It can be reached by railroad and local accommodations are good.

The party will concentrate on the observation of phenomena which cannot be observed at any time other than during a total solar eclipse. Observations will be made both visually and photographically of the outer corona and the zodical light in the vicinity of the sun and will time precisely the four contacts, that is, the four times when the disks of the sun and moon will be tangent to each other.

Professor Smiley states, "Modern devices including highly selective colour filters allow astronomers to observe the *inner* corona of the sun on almost any clear day, but to date no instrument has been devised which will allow the observation of the *outer* corona and the measurement of its brightness except at total solar eclipses."

The National Geographic Society also plans, in cooperation with the United States Army Air Forces, to observe the total eclipse in Brazil. In this connection the National Broadcasting Company sends the following information as to its activities.

NBC will send a commentator, a crew of radio engineers, and television motion picture personnel with the expedition, which is being directed by Dr. Lyman J. Briggs, chairman of the National Geographic Society's research committee. A score of scientists will set up a portable laboratory near the town of Bocayuva, about 400 miles north of Rio de Janeiro.

Broadcasts will be made before, during, and after the eclipse, which will start about 7.35 a.m. Eastern Standard Time. The period of totality will be about four minutes. As film stories become available during the expedition, they will be flown to the United States for showing over NBS television outlets.

F. S. H.

MEETINGS OF THE SOCIETY

AT TORONTO

February 12, 1946—The Society met at 8.00 p.m. in the McLennan Physics Laboratory, University of Toronto; Mr. H. W. Barker, the President, in the chair. Dr. Helen Sawyer Hogg drew attention of the members to some current astronomical phenomena, including a large sun-spot group, and the recent great increase in brightness of the recurring nova T Cor.Bor. Mr. J. R. Collins reported the recent discovery at the Vatican Observatory of a comet.

Mr. T. H. Mason moved that the Centre extend its congratulations to Dr. Frank S. Hogg on his elevation to the positions as head of the Department of Astronomy in the University of Toronto, and Director of the David Dunlap Observatory. This was carried unanimously.

Professor V. B. Meen, Ph.D., associate director of the Royal Ontario Museums of Mineralogy and Geology, addressed the meeting on "Stones from Heaven—Meteorites." A synopsis follows:

Meteorites are bits of matter from out of space, possibly fragments of some pre-existent body that has disintegrated. Their incandescence as they pass swiftly through the earth's atmosphere is monentary; they soon lose their brilliancy as they are slowed up by their passage through the air, and the few fragments which reach the earth's surface do so at relatively slow velocity. The larger fragments may penetrate the soil a few feet, while the smaller ones are likely to rebound. Their duration of flight through the atmosphere is too short for the heat caused by friction with the air to penetrate, and those which reach the ground are only slightly warm, and quickly cool off. Some show lines of flow of molten material from the front to the back, in addition to the curious but characteristic pittings which are called "thumb-prints." The irregular shapes of meteorites indicate they are only fragments of larger bodies.

Astronomers analyze the distant stars spectrographically, but they can take these "little bits of haven" into the laboratory for complete quantitative analysis. No element has been found in meteorites that is not known on earth, but many terrestrial elements have not been found in meteorites. Although consisting of well-known chemical elements, largely iron and nickel or basaltic stone, meteorites exhibit very different mineralogical structures to those found in terrestrial rocks. The carbon content usually is in the form of graphite, but occasionally very small diamonds have been found. Some meteorites are very high in metallic content, others very low. They are commonly grouped in three classes: (1) siderites which are largely of iron-nickel content; (2) aerolites which are mainly stony in structure, and (3) siderolites, which are partly stony and partly nickel-iron. Even the metallic constituent is not uniform,

the percentage of nickel varying from 3 to 20. The average composition of 160 siderites gave 90% iron, 8.7% nickel, 0.69% cobalt, with traces of copper, chromium, phosphorus, sulfur and carbon. Some of the aerolites in outward appearance are so similar to terrestrial rocks that except for their glassy black surface they would be almost indistinguishable.

Dr. Meen described some of the falls of meteorites in history, including mention of "coals of fire" in Psalm 18, and the Chinese record of the fall of a star which turned to stone. Until fairly recent times, scientists refused to place belief in the possibility of the origin of meteoric matter in outer space, and credited them to matter ejected into the air by volcanic eruptions and to the fusing of rocks by lightning.

To date there have been slightly more than 1,000 falls from which specimens have been preserved, and there are on the average about 10 new falls each year. Of 250 siderites preserved in collections, only 20 were seen actually to fall, while of 600 aerolites nearly all the falls were witnessed. More than 100,000 fragments were recovered after a great shower of meteors in Poland in 1868. The Cape York meteorite, found by Peary in Greenland and now in the American Museum of Natural History in New York, weights 36½ tons and is the largest ever found. A meteorite has been credited as the cause of Meteor Crater at Canon Diablo, Arizona, but no mass has been found although thousands of small fragments were picked up around the crater. It was possible the crater was formed by an explosion in the mass of meteoric matter as it passed close to the ground.

Fine collections of meteorites have been built up in London, Chicago, Vienna, Paris and other museums. The Royal Ontario Museum has a small collection and was always glad to acquire authentic specimens, Dr. Meen said, "but we have not the financial resources to bid against the larger institutions in the U.S. Meteorites have no great intrinsic value but their rarity brings keen competition in the market from museum curators." Many supposed meteorites offered, however, turned out to be clinkers or common rocks.

A few meteorites have been known to strike buildings and to have broken through roofs, but there were few, if any, authentic records of any person having been injured or killed by these "stones from heaven." Despite the great number of bits of meteoric matter which come plunging down toward earth through the atmosphere, this air was such a good protective blanket that humanity should not find it necessary to go about wearing steel helmets or to live in bomb-proof shelters, Dr. Meen concluded.

FREDERIC L. TROYER, *Recorder*

AT VANCOUVER

October 8, 1946.—The first meeting of the Vancouver Centre for the 1946-47 season was held in the Science Building, University of British Columbia, with the Vice-President, Mr. N. Barton, in the chair. Mr. Barton announced that the Centre had received a request for observations to be made of the expected

shower of the Giacobinid meteors on the night of October 8, 9, and 10. He then called on the speaker of the evening, Dr. J. A. Pearce, Director of the Dominion Astrophysical Observatory, Victoria, B.C. First Dr. Pearce gave the members more information about the Giacobinid meteors. He then began his main topic, "The Pleiades", by stating that in the evenings this season of the year there appeared in the eastern sky a small group of stars, of which only six or seven in the form of a small dipper are visible to the naked eye. Telescopes reveal many more stars in this group. Dr. Pearce emphasized the interest this group has for astronomers by stating that probably no other group of stars has been studied so intensively. Next, he discussed various suggestions for the name Pleiades. His own opinion is that they were so named because the Greeks considered them as the daughters of Pleione and Atlas, who were transported to the sky because of their grief at the death of their father, Atlas. Passing from the legends to a discussion of observations of the Pleiades, Dr. Pearce mentioned that the first recorded observations of the positions of the stars were made by Hipparchus, who included four of the Pleiades in his list, which Ptolemy included in his Almagest. The first map of the Pleiades including stars invisible to the naked eye was made by Galileo. Dr. Pearce said that many of the stars in the Pleiades have been identified as members of a moving cluster by the proper motion studies of Trumpler and Van Manaan. Much work on investigation of radial velocities of the members of the cluster has been done by Dr. Pearce. After the conclusion of the lecture, which was copiously illustrated by slides, Dr. Shrum moved a vote of thanks to Dr. Pearce.

C. D. MAUNSELL, *Recording Secretary.*

OBSERVER'S HANDBOOK, 1947

Those members who have received their copies of the 1947 Observer's Handbook, but are not planning to continue their memberships in 1947, are requested to send the price of the Handbook to the Local or General Treasurer.

F. S. H.

The Royal Astronomical Society of Canada

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